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DEMONSTRATION OF SAFECOAT FORMULA 451®

Alberta
MUNICIPAL AFFAIRS
Housing Division

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SAFECOAT FORMULA 451® DEMONSTRATION

FEBRUARY 1991

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EXECUTIVE SUMMARY

The objectives of the study were to document the performance of SAFECOAT Formula 451® manufactured by Marathon Coatings Technology Ltd. of Edmonton, and to document its use at the Rosehaven Long Term Seniors Care Facility in Camrose. The roof of the facility which burned in June, 1990, was being replaced by a wood structure, deemed the only feasible method of construction to replicate the intricate roof. Marathon Coatings Technology Ltd. provided both the product and its application to the framing and sheathing wood products used in the reconstruction.

SAFECOAT Formula 451® is a latex-based product and its properties and method of application are virtually identical to any latex-based paint. Because its application is like an ordinary painting application, schedules and timelines were easily met and adjustments to quantity estimates did not result in significant delays for the project. Transportation of the coated wood did not involve special handling because the coating duplicated the durability of a latex paint on wood and minor scratches or dents do not effect the fire-retardant properties of SAFECOAT Formula 451®.

SAFECOAT Formula 451® has been tested by a number of authorities including Warnock Hersey Laboratories, Weyerhaeuser Fire Technology Centre, and Alberta Research Council and has been designated as a Class A Fire Retardant with Fire Suppression Index values ranging from 10 to 25, and Smoke Development Index values ranging from 45 to 137 depending on substrate and thickness of coating. SAFECOAT Formula 451® results in cost savings over traditional pressure-treated fire-retardant materials, particularly in larger dimensions and thicknesses. A further advantage is that use of the product does not result in reduction in strength of plywood or produce deleterious reactions with metal fasteners which could, in turn, result in structural failure. The product offers cost savings of between 11.8% and 14.7% when

applied to standard plywood sheathing and wall and floor framing materials, and further cost savings when less expensive Oriented Strand Board (which cannot be made fire retardant by traditional pressure-treating techniques) is used in place of plywood sheathing. Because the product resembles an opaque paint product, its application is straightforward and because a single coat provides flame-spread protection, it affords further economies of time and labour over multi-coat fire retardants.

A demonstration of SAFECOAT Formula 451® reveals the effectiveness of the intumescent nature of the product, that is, the expansion under heat and subsequent charring which protects the wood beneath. Use of the product is permitted under the Alberta Building Code as a fire-retardant interior finish. Examination of related sections of the Alberta Code indicate that some re-wording of definitions as well as a regulatory examination of the use and properties of the product could result in its wider application towards the goal of reducing property losses and hazards to building occupants in a variety of situations.

1.0 INTRODUCTION

1.1 Purpose of the Study

Development of SAFECOAT Formula 451® by Marathon Coatings Technology Ltd. was recently assisted by Alberta Municipal Affairs through its Innovative Housing Grants Program. In October 1990, Marathon Coatings Technology Ltd. secured a major commercial contract involving the application of SAFECOAT Formula 451® to approximately eight hundred sheets of plywood and 45,000 board feet of dimension lumber, comprising the new roof structure to the Rosehaven Long Term Seniors Care Facility in Camrose. The original roof structure was destroyed by fire in June 1990. The purpose of this project was to demonstrate the use and utility of SAFECOAT Formula 451®.

1.2 Description and Background of the Product

SAFECOAT Formula 451® is a Code-approved, "high solids", latex-based "intumescent" fire-retardant surface coating intended for application on wood building materials.[1] The product offers surface characteristics similar to fully opaque satin latex finishes in white or other pastel colours and is applied in a similar manner to latex paints and coatings. As a water-based system, it therefore does not contribute alkyd-based fuels to combustible materials such as wood, particle board, and other composite materials.

Marathon Coatings Technology Ltd. began developing SAFECOAT Formula 451® in early 1989 to meet a need for a fire retardant for fibreboard ceiling panels which would be "forgiving" enough to allow for the introduction of a myriad of small holes into a panel without affecting its flame spread rating. The product then underwent further development as a coating for commercially-available commodity boards. Subsequent testing by such organizations as Alberta Research Council and Weyerhaeuser Canada Ltd. has imparted increased presence and acceptance to the product in the construction materials marketplace.

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1 The product is so described in Alberta Labour, Building Standards Branch, STANDATA Product Listing No. 85-PL-190, p1.

1.3 Project Description

1.3.1 Project History

Rosehaven Long Term Seniors Care Facility is an institution offering long-term seniors care located in Camrose, Alberta. The oldest portion of the complex, the Main Building, is a four-storey masonry-and-concrete structure with a wood roof and is registered as an Alberta Historic Site. The building was undergoing extensive renovations as part of an overall expansion and renovation of the facility at the time of the fire.

On the afternoon of June 18, 1990, according to the Camrose Fire Department report[2], a glazing contractor was using an open flame to heat a membrane of a new roof section to connect it to the existing west wall of the building, just below one of the windows. In the absence of any flashing or backing strip below the window sill, it is surmised that the flame ignited some old wood shavings or a concealed portion of the wood window frame and that fire subsequently spread upward through the counterweight channels in the frame, igniting the roof. The glazing subcontractor left the site and work at the site ceased for the day. Because the existing building was under renovation, it was unoccupied. The fire alarm system was not yet completed, therefore, the fire was undetected in its early stages. The existing roof, being clad in fire resistant shingles, contained the blaze within the attic space for approximately two hours until flames

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2 This material, as well as video documention of the fire, was obtained in an interview with Camrose Fire Chief, George McCrae, December 10, 1990.

penetrating the roof were noted at just before 7:55 that evening. Rigs from the Camrose Fire Department were on site a few minutes later, and found much of the roof already on fire, with the portion nearest the start of the fire in danger of imminent collapse. Fire personnel concentrated on containing the blaze and preventing embers and collapsing roof overhangs from igniting the roof of the newer portion of the institution. Although portions of the roof overhang fell away from the original building and landed on various parts of the new structure, the new structure escaped any damage save some firefighting water which migrated into the new structure .

The wood roof of the original structure was completely destroyed. Steel trusses in the centre section were warped from the heat and were unsalvageable. Two masonry turrets on the east face of the building flanking the centre portion of the building were supported by steel substructures which were damaged in the fire **(Fig A)**. The south turret collapsed; the other was severely weakened and later dismantled. Air handling equipment already installed in the roof space as part of the renovation collapsed with the roof and required replacement **(Fig B)**. Damage to the masonry was relatively minor around the perimeter of the building with portions of the upper brick walls weakened due to heat-induced failure of the bond between brick and mortar. Surprisingly, water damage to the floors below was minimal due to the concrete structure of the building and the terrazzo coves and flooring which directed the water from the firefighting efforts along the third floor corridors and down the north

and south staircases. Property loss was estimated at $1,200,000.

The Consultants for the building expansion and restoration, MWCGS Architects Ltd, were immediately commissioned to undertake replacement and restoration of the roof, repair of fire damage to the upper part of the masonry walls and to the front turrets, refabrication and re-erection of steel trusses in the roof, and replacement of damaged windows and casings.

1.3.2 Use of the Product

Because the Main Building of Rosehaven Institute was an Alberta Historic Site, restoration of the roof of the building was mandated rather than replacement with another type and configuration of roof. The complexity of the roof form made wood the most economical type of construction material to be employed. However there were some regulatory and practical considerations which needed to be addressed.

The Rosehaven facility is classified under the Alberta Building Code as an Institutional Occupancy, Group B, Division 2, "in which persons because of age, mental or physical limitations require special care or treatment." Sentence 3.2.2.26(2) stipulates that buildings the size of the subject building are required to be of noncombustible construction. This requirement precludes the use of dimension lumber for roof framing and plywood for roof sheathing, which were most economical for this project, even if those materials have been fire-retardant treated. However, due to the historic nature of the

building and the complexity of the roof profile, authorities at Alberta Labour, Building Standards Branch allowed the use of a fire retardant wood roof system, and as an extra precaution, mandated the installation of a sprinkler system in the roof space.

The selection of a fire retardant system involved discussion with a number of manufacturers interested in the selection of their respective products. The selection of the SAFECOAT Formula 451® coating by Marathon Coatings Technology Ltd. was, in the end, influenced by several factors:

.1 Product cost

Application rates for SAFECOAT Formula 451® as mandated in Standata No. 85-PL-190 resulted in substantial cost savings over other surface-applied coatings and particularly over pressure-applied materials. Tables 1 and 2 give some examples of costs[3] of rendering various sheathing and framing materials fire retardant through the application of SAFECOAT Formula 451® and through pressure-treating.

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3 Costs based on quantities comparable to the Rosehaven project.

Table 1

Cost Comparisons of SAFECOAT Formula 451®
and Pressure Treating to Various Sheathing Materials

Item	SAFECOAT Formula 451®	Pressure-Treated
A. Plywood Sheathing 1220 x 2440 x 11 mm (7/16" x 2' x 4')		
Plywood Cost	$ 11.95	$ 11.95
Pressure Treating	N.A.	16.90
SAFECOAT Coating	13.50	N.A.
Finished Costs	**$ 25.45**	**$ 28.85**

Cost Savings: SAFECOAT Formula 451® applied to plywood results in a 11.8% cost savings over pressure-treated, fire-retardant plywood sheathing.

B. Plywood Sheathing 1220 x 2440 x 12.7 mm (3/4" x 2' x 4')		
Plywood Cost	$ 22.50	$ 22.50
Pressure Treating	N.A.	19.50
SAFECOAT Coating	13.50	N.A.
Finished Costs	**$ 36.00**	**$ 42.00**

Cost Savings: SAFECOAT Formula 451® applied to plywood results in a 14.3% cost savings over pressure-treated, fire-retardant plywood sheathing.

C. Oriented Strand Board Sheathing Alternative 1220 x 2440 x 12.7 mm (3/4" x 2' x 4')	
Oriented Strand Board Cost	$ 7.20
Pressure Treating [4]	
SAFECOAT Coating	13.50
Finished Costs	**$ 20.70**

Cost Savings: SAFECOAT Formula 451® applied to O.S.B. results in a 28.2% cost savings over pressure-treated, 11mm fire-retardant plywood sheathing.

[4] Due to the wax coating and absorbent nature of the strands, Oriented Strand Board cannot be pressure treated.

Table 2

Cost Comparisons of SAFECOAT Formula 451® and Pressure Treating to Various Framing Materials

Item	SAFECOAT Formula 451®	Pressure-Treated
D. Framing Lumber		
2 x 6 nom. per lin. ft.	$ 0.32	$ 0.32
Pressure Treating	N.A.	.50
SAFECOAT Coating	.40	N.A.
Finished Costs	**$ 0.72**	**$ 0.82**

Cost Savings: SAFECOAT Formula 451® applied to plywood results in a 12% cost savings over pressure-treated, fire-retardant plywood sheathing.

E. Floor Framing Lumber		
2 x 10 nominal per lin. ft.	$ .66	$ .66
Pressure Treating	N.A.	.84
SAFECOAT Coating	.65	N.A.
Finished Costs	**$ 1.28**	**$ 1.50**

Cost Savings: SAFECOAT Formula 451® applied to plywood results in a 14.7% cost savings over pressure-treated, fire-retardant plywood sheathing.

.2 Toxicology

In selecting a finish for this project, consideration was given to the issue of the potential toxic nature of the coatings to be used. The Federal Workplace Hazardous Materials Information System (WHMIS) reporting standards require that manufacturers label all products that carry more than 1% of any substance which could be hazardous to the health of those who come in contact with it. At this time, Alberta Labour, Building Standards Branch, does not consider WHMIS information when issuing STANDATA product certification.

Nonetheless, because of the use of the building, toxicology was a significant consideration and Marathon Coatings was able to provide Material Safety Data Sheets[5] from a qualified industrial hygienist attesting that SAFECOAT Formula 451® is relatively innocuous in both its wet and final dry states, requiring similar procedures to the application of latex paint. Other products under consideration were not able to provide acceptable evidence of their WHMIS status.

As regulatory and liability pressures cause the effect of building products on the health of building occupants to become an increasingly important issue, it is not unreasonable to assume that a Material Safety Data Sheet by a qualified industrial hygienist will become a prerequisite for a STANDATA product listing.

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5 Prepared by MSDS Chem Consulting, Calgary, Alberta, November 9, 1990

.3 Availability and reliability of test data

The issues of toxicology, flame-spread ratings, method of application, etc. underscored the need for a thorough base of product background test data to enable the designer to specify a new product, and regulating authorities to permit a new product's use in a given situation. When the data are presented in a clear, concise manner, evaluations of a product's characteristics and efficacy are much more easily evaluated.

.4 Opacity

Although SAFECOAT Formula 451® is inherently a milky-white substance, titanium, the standard base of most latex paints, is added to the product to impart an opaque, white colour. The result is a simple instrument of quality control which enables a quick visual check to ensure that a wood element has been treated. (A secondary benefit to the white colour of the product is its light reflectivity which makes the lighting of concealed spaces much more effective where the product is used) **(Fig C).** Clear products, or those which require multiple coats to achieve the desired flame-spread rating, are more difficult to monitor.

If there is doubt as to whether or not the product is SAFECOAT Formula 451® or ordinary paint, a simple test conducted with a match is possible: if intumescence occurs in contact with flame, the product is in place.

.5 Ability to be field-applied

Unlike products applied under pressure, the cost and convenience of a field-applied product is important where quantities are limited, distances to workplace are great, or schedules are compressed.

.6 Delivery time and schedule support

SAFECOAT Formula 451® is manufactured in Edmonton and was supplied and applied, for this project, by the manufacturer. This single source arrangement for product and application ensured that the job would be completed "as per manufacturer's recommendations." It also resulted in tighter controls exercised over the delivery of the product and application services.

In addition, the manufacture of this product can be undertaken, via license or franchise, by any qualified paint manufacturer and, in most markets, it can be produced in fairly large quantities in a short period of time. Inasmuch as the product can be applied by painters of moderate skill, a controlled application site can easily be set up in an indoor space near the final building site.

.7 Support of a locally-manufactured product

As has been noted, SAFECOAT Formula 451® is an Alberta-manufactured product and, in permitting its use, the Client was supporting a local manufacturer.

2.0 REGULATORY CONSIDERATIONS

2.1 Pertinent Regulations

Sentence 3.2.2.26(2) of the Alberta Building Code (1985) stipulates that buildings the size and type of the subject building must be of noncombustible construction. Roof assemblies are required to have a 1-hour fire-resistance rating and all loadbearing walls, columns and arches must have a fire-resistance rating at least equivalent to that required for the supported assembly. Furthermore, Sentence 3.2.5.5(6) requires that any building having a storey higher than 8 meters above grade must be sprinklered. Subsection 3.1.12. describes the test for a fire retardant roof system. Sentence 3.2.2.8(1) waives the requirement that a roof assembly have a fire-resistance rating if the building is sprinklered by an electrically-supervised system, which system automatically signals the fire department if operated, and if the roof does not support an assembly occupancy. Note that a fire-retardant wood roof system is not deemed to be a noncombustible construction system nor does the installation of a sprinkler system waive this requirement for non-combustible construction. Therefore, the product's use on a combustible roof system in this size and classification of building is mandated by an exceptional situation; in this case, the historic nature of the structure.

2.2 Regulatory Approach

The Alberta Building Code strictly defines the regulatory function of a fire-resistance rating and a flame-spread rating. The former is defined in the Code as "the time in hours or fraction thereof that a material or assembly of materials will withstand the

passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived therefrom as prescribed in this Code".[6] This rating is expressed as a time factor, i.e. 45 minutes; two hours. Flame-spread rating is classified as "an index or classification indicating the extent of spread-of-flame on the surface of a material or an assembly of materials as determined in a standard fire test as prescribed in this Code". This rating is expressed as an integer on a comparative testing scale[7] where "0" refers to asbestos-cement, which is noncombustible, and "100" applies to unpainted Grade A red oak, which is completely combustible.

In general, the building code uses fire-resistance ratings of construction assemblies to control and contain the spread of fire through a structure. Through the erection of construction assemblies having a fire-resistance rating ("fire separations") a fire can be confined to certain limits until firefighters have a chance to extinguish it. On the other hand, flame spread ratings are most often utilized as a device to protect the occupants of a building in preventing "flashover" and limiting the production of smoke and toxins on the surfaces of critical rooms and spaces in a building, for example assembly spaces and exits.

The deficiency of the fire separation approach in protecting combustible roof structures has been demonstrated at the Rosehaven fire in Camrose, and in numerous other fires where, once they have entered the roof space, fires spread much faster than they would if they occurred on lower levels of the structure where

6 ULC "Vertical Furnace Test" designated as ULC CAN4 S101
7 ULC "Steiner Tunnel Test" designated as ULC CAN4 S102M.

vertical fire separations slow and contain the spread of flame. Since a horizontal fire separation (i.e. a ceiling immediately below the roof) experiences a much greater effect of flame and heat against it, it is much more vulnerable to being breached, particularly through any imperfections within it. The erection of more vertical fire separations within roof spaces is a possible solution, but this increases building costs and creates possible sites for water penetration where these fire separations must penetrate the roof.

Demonstrations and testing of SAFECOAT Formula 451® suggest that its use in roof cavities could offset the property losses which are incurred when the combustible roof of a structure is burned off at a rapid rate. However, the use of a flame-spread retardant to perform some of the function of fire separation with a fire-resistance rating would constitute a new direction for the code - one which would require further study to create a set of guidelines for product use, and coordination of product relationships to other sections of the Alberta Building Code.

2.3 Potential Regulatory Impacts

The Alberta Building Code Sentence 3.1.12.(1) - Roof Assemblies, states: "Where a fire-retardant treated wood roof system is used to comply with the requirements of Subsection 3.2.2., the roof deck assembly shall meet the conditions of acceptance of ULC-S126M 'Standard Method of Test for Fire Spread Under Roof-Deck Assemblies.' " Subsection 3.1.12.(2) states: "Supports for the roof deck assembly in Sentence (1) shall consist of:

(a) fire-retardant treated wood
(b) heavy timber construction
(c) noncombustible construction, or
(d) a combination thereof."

The test procedure, ULC-S126M, uses the same apparatus and test methodology as CAN4-S102, the standard flame-spread test for materials used as interior finishes, except that ULC-S126M subjects the sample to the flame for thirty minutes instead of ten minutes for CAN4-S102. SAFECOAT has been tested in the United States and has passed all the requirements for FRT panels in the ULC and American Plywood Association (APA) protocols. SAFECOAT Formula 451® and similar products, by imparting sufficient protection to a substrate to withstand a 30-minute test, could greatly expand the range of uses for pretreated or site-finished lumber and sheathing. Such a scenario may result in the possible alteration of some definitions in the Alberta Building Code. Section 1.3 of the Alberta Building Code defines "fire-retardant treated wood" as "wood or a wood product that has had its surface-burning characteristics, such as flame spread, rate of fuel contribution, and density of smoke developed, **reduced by impregnation** with fire-retardant chemicals" (Emphasis added). If SAFECOAT Formula 451® is deemed by authorities as a fire-retardant treated wood treatment, then it may be that the definition for fire-retardant treated wood be enlarged to encompass surface-applied coatings which have effects similar to pressure-applied chemicals.

3.0 DEMONSTRATION AND APPLICATION

3.1 Demonstration and Observations

On December 14, 1990, a test of the product was conducted to demonstrate its effect on a mock-up roof assembly. For the purposes of the test, two sample gable sections were constructed measuring 1200 mm x 1200mm x 1200mm **(Fig D)**. The two samples were constructed of 38 x 89 mm dimension lumber framing, 19 x 38 mm cross-ties, and Oriented Strand Board ("chip board") sheathing. The sheathing was eliminated for a portion of the "roof slope" to allow visibility during the test. A wind baffle partially enclosing the other gable end was installed to minimize the effect of wind on the course of the flame. The samples were identical except that one was coated with the SAFECOAT product on the inside face which came in contact with the flame source. One framing member of the untreated sample was painted with one coat of standard latex paint so that markings at approximately 330 mm intervals could be visible. One hundred fifty ml of gasoline was used as a fuel and this was placed in a 4-litre metal container. The fuel source was placed in the lower rear corner of the gable structure where wind would have minimum interference with the action of the flame. A fixed camera was placed so that the progress of the flame on both samples could be recorded simultaneously and a clock was placed near the samples to record elapsed time. A hand-held camera was used to record various other views of the test. Field notes and a narrated video record were also made during the test.

The following observations were made at specific times:

0:00 Fuel ignition. **(Fig E)**

0:50 Untreated sheathing involved. **(Fig F)**

0:55 Visible expansion of intumescent coating on treated sample noted. **(Fig G)**

1:40 Spread of flame along coated surface of treated sample promotes rapid expansion and charring of product with resultant smoke; production of combustion smoke in untreated sample. **(Fig H)**

2:10 Framing members of untreated sample involved; spread of frame along surfaces of treated sample subsides. **(Fig I)**

3:47 Combustion continues to spread in untreated sample; treated sample coating continues to expand and char although no combustion is noted as flame subsides further. **(Fig J)**

5:05 Upper portion of untreated sample completely involved; condition of treated sample largely unchanged. **(Fig K)**

7:00 Fuel source in both samples exhausted; smoke production and charring ceases immediately in treated sample, combustion spreads in untreated sample. **(Fig L)**

7:20 Fuel source under treated sample replenished and re-ignited. **(Fig M)**

10:30 Treated sample shows expansion of intumescent coating; flame penetrates sheathing of untreated sample. **(Fig N)**

15:30 Fuel source under treated sample is exhausted for the second time; structural failure of portions of untreated sample noted, most of sample involved.

18:25 Flames subsided in untreated sample due to lack of fuel. **(Fig O)**

20:00 Remaining flames in untreated sample extinguished by testers.

22:00 Charred intumescent coating from treated sample scraped away to reveal virtually unharmed sheathing underneath. **(Fig P)**

3.2 Conditions for Application

The SAFECOAT Formula 451® product is latex-based and can be applied at temperatures above 4.4°C. The product is non-toxic and requires only the usual precautions associated with spraying latex paints. SAFECOAT Formula 451® has a shelf-life of at least one year and must be kept in tightly-sealed plastic containers until ready for use. Like any paint product, SAFECOAT Formula 451® should be applied under well-ventilated conditions. The wet product must be protected from frost before and after application or until dried.

3.3 Methods of Application

SAFECOAT Formula 451® is well-suited to airless spray equipment. When applied by airless equipment, the product goes on in a single application at 9.63 mil. of wet film (5.5 mil dry) for SPF plywood and 10.7 of wet film (6.125 mil dry) for OSB. Other methods of application, such as brush, roller, or curtain coater, require caution in ensuring that the film thickness attained is of the required level to achieve the flame-spread rating. This may require more than one coat when using a brush or roller.

3.4 Lumber Ratings

In applications where the lumber is being used for certain Code-specified structural purposes, such as engineered trusses, the applicator must cover the AFPA grade stamps with clear plastic packing tape or some other kind of easily-removed paint shield before applying the product. When the coating is dried and the shield is removed, the resulting small rectangular area that is exposed **(Fig Q)**, revealing the lumber stamp, is less that 0.01% of the surface area and will not substantially affect the flame spread rating of the roof assembly.

3.5 Other Issues

3.5.1 Acid Hydrolysis

One aspect of traditional pressure-treated, fire retardant plywood which has emerged in the United States and is now beginning to attract attention in Canada is the effect of the acidic salts impregnated in the material. Two phenomena have been observed and documented[8]. The first phenomenon is the deterioration of galvanized steel connectors – nails, gangnails, plates, straps and hangers – which come in contact with the fire resistant material. This action accelerates in direct proportion to increasing humidity and can lead to roof failure.

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8 "Fire-Retardant Treated Plywood", *The Building Official and Code Administrator,* March/April 1989, p. 6.

The second aspect, far more serious and difficult to overcome, is the noticeable deterioration of the structural capacity of pressure-treated, fire retardant lumber after treatment. A preliminary test conducted by the Forestry Division of the Alberta Research Council[9] of other products by Marathon Coatings Technology Ltd. included a sample of fire-resistant plywood (FRP) for structural testing. Tests showed that after 28 days, the FRP sample had lost 27% of its inherent load-carrying capacity defined as modulus of rupture (MOR). There are indications that this deterioration does not appreciably stop over time and that the MOR ratings for FRP may need to be downgraded substantially. Furthermore, as in the case of up to one million townhouse buildings in the United States, retrofitting or replacement may be the only solution for pressure-treated plywood roof systems installed over the last fifteen years.[10]

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9 Wellwood, Robert, Alberta Research Council, Report FPLE 310 "Preliminary Testing of Coated OSB prepared for Weyerhaeuser Canada Limited", Table I-1, Edmonton, Alberta, Ref. 40601429 89-PFP-32, May 25, 1990.

10 McDonald, Timothy B, "Under Fire", *Architecture*, BPI Communications, Washington DC, April 1990, vol 79, no.4, p. 99.

4.0 INSTALLATION

4.1 Product Transportation and Storage

SAFECOAT Formula 451® is not subject to special handling considerations for transportation except that it must be kept from freezing. Shelf life for the product, when stored in tightly-sealed, plastic containers, is at least twelve months.

4.2 Handling and Installation of Coated Elements

Unlike surface applied fire retardants used for steel members which do not form a substantial bond with the structural member coated, SAFECOAT Formula 451® achieves a bond to wood surfaces virtually identical to paint. Installed within the temperature ranges specified by the manufacturer, the product will not chip or flake. The coating will also conform to minor dents or impact depressions which occur on a wood surface during transportation and erection or once in place. Therefore no special handling or storage considerations are needed beyond those which are normally adopted for dimension and sheet lumber.

4.3 Field-Derived Suggestions for Installation

Field application is most cost-effective when applied by a Grayco Airless sprayer. These units will pump up to four litres per minute, so care must be taken to avoid excess application in order to reduce waste. The SAFECOAT Formula 451® product is supplied pure white in colour from the factory (although it may be coloured in the pastel range). When applying the product, coverage is monitored by the amount of hiding offered. If the grain of the wood is hidden, the rating and coverage is

usually adequate. One coat by airless sprayer is sufficient to offer the required Class A Flame Spread Index of less than 25. Warnock Hersey Professional Services has measured the wet and dry film at 180 and 200 square feet per Imperial gallon.

The weight for each coverage is as follows:

Table 3

Coverage Comparisons of SAFECOAT Formula 451®
Under Wet and Dry Conditions

Coverage (m^2)	Weight of SAFECOAT (g)	Weight (g)	Film Thickness (mil)
16.72	31.57	20.48	10.70 (wet)
18.58	28.41	20.48	9.63 (wet)
16.72	31.57	20.48	6.13 (dry)
18.58	28.41	20.48	5.50 (dry)

For trusses and dimensional lumber, optimum coverage and economy are gained when the materials are coated before being cut and assembled. If application is left until after the trusses are manufactured or when the framing lumber is in place, airless spray application results in substantial loss due to overspray.

Sheathing materials may be coated at any time. Once again, job site conditions will dictate the most cost-effective procedures. If additional scaffolding is required to apply the product, or if temperatures at the site are anticipated to be lower than 4.4°C, prefinishing may be preferable to site finishing.

5.0 CONCLUSIONS

In certain building code applications, the use of site-applied or factory prefinished dimensional lumber and sheathing coated with SAFECOAT Formula 451® may be a viable alternative to pressure-treating lumber or installing gypsum board inserts to achieve a Class A Flame Spread Index of less than 25.

SAFECOAT Formula 451® offers a number of advantages over pressure treated lumber; namely, lower cost, immunity to acid hydrolysis, ability to be field- or factory-applied with a minimum of special equipment, and elimination of lead times and delivery times which arise with pressure-treated materials.

SAFECOAT Formula 451® currently offers benefits to the specifier and the regulatory authorities in the amount of test data completed to date, and in its final appearance where simple visual field checks can be performed to ensure adequate coverage.

SAFECOAT Formula 451® offers distinct advantages where change of use, Building Code requirements, or insurance liability requirements mandate a Class A FSI of 25 or less. The product offers an attractive and cost effective alternative to gypsum inserts or other multiple-application fire retardant coatings in roof cavities or concealed spaces.

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Figure A
View of Rosehaven during fire showing collapsed roof and turrets.

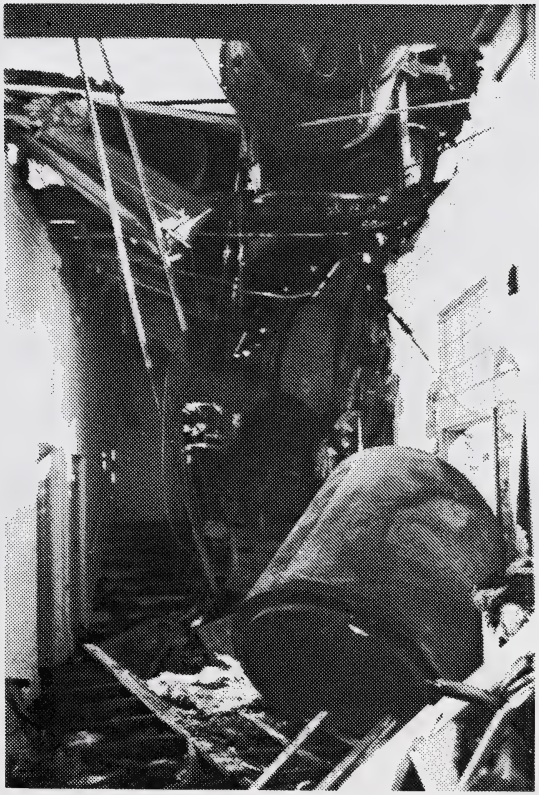

Figure B
Post-fire view of upper floor interior showing effects of fire on roof members and HVAC equipment.

Figure C

Two views of coated members in place showing inherent light reflecting qualities of material.

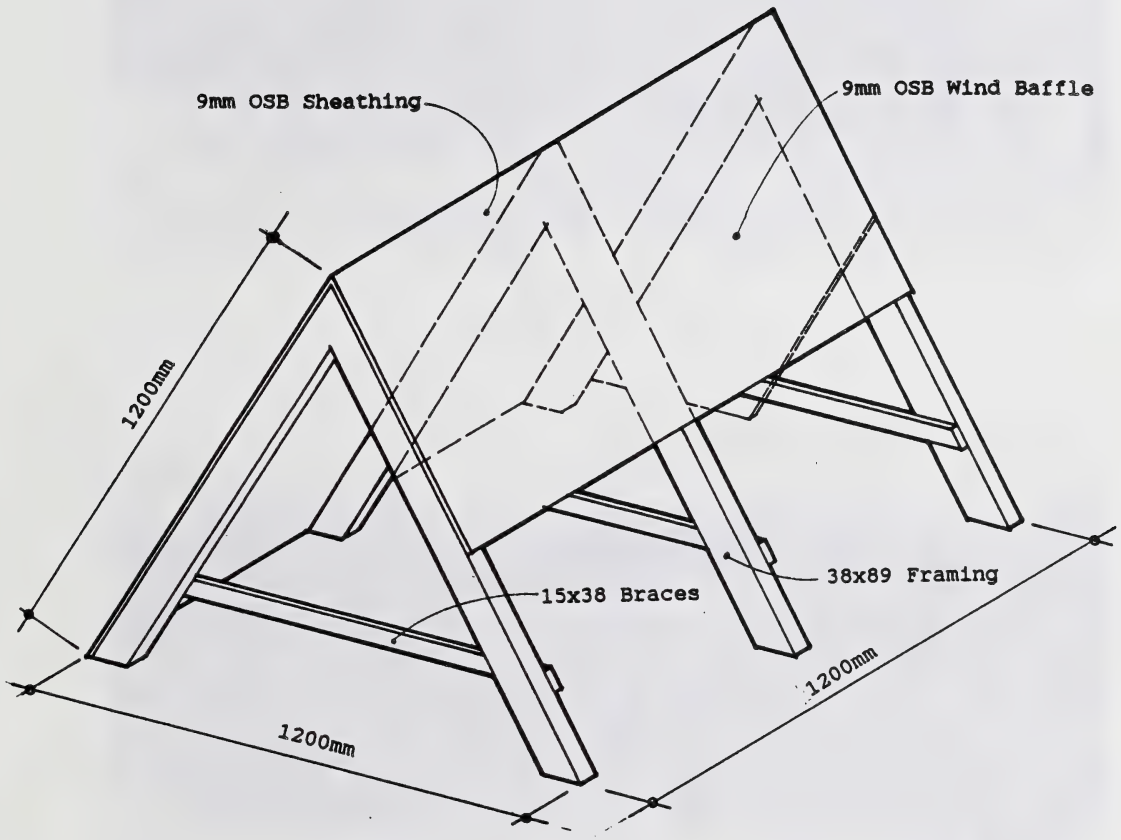

Figure D
Test sample.

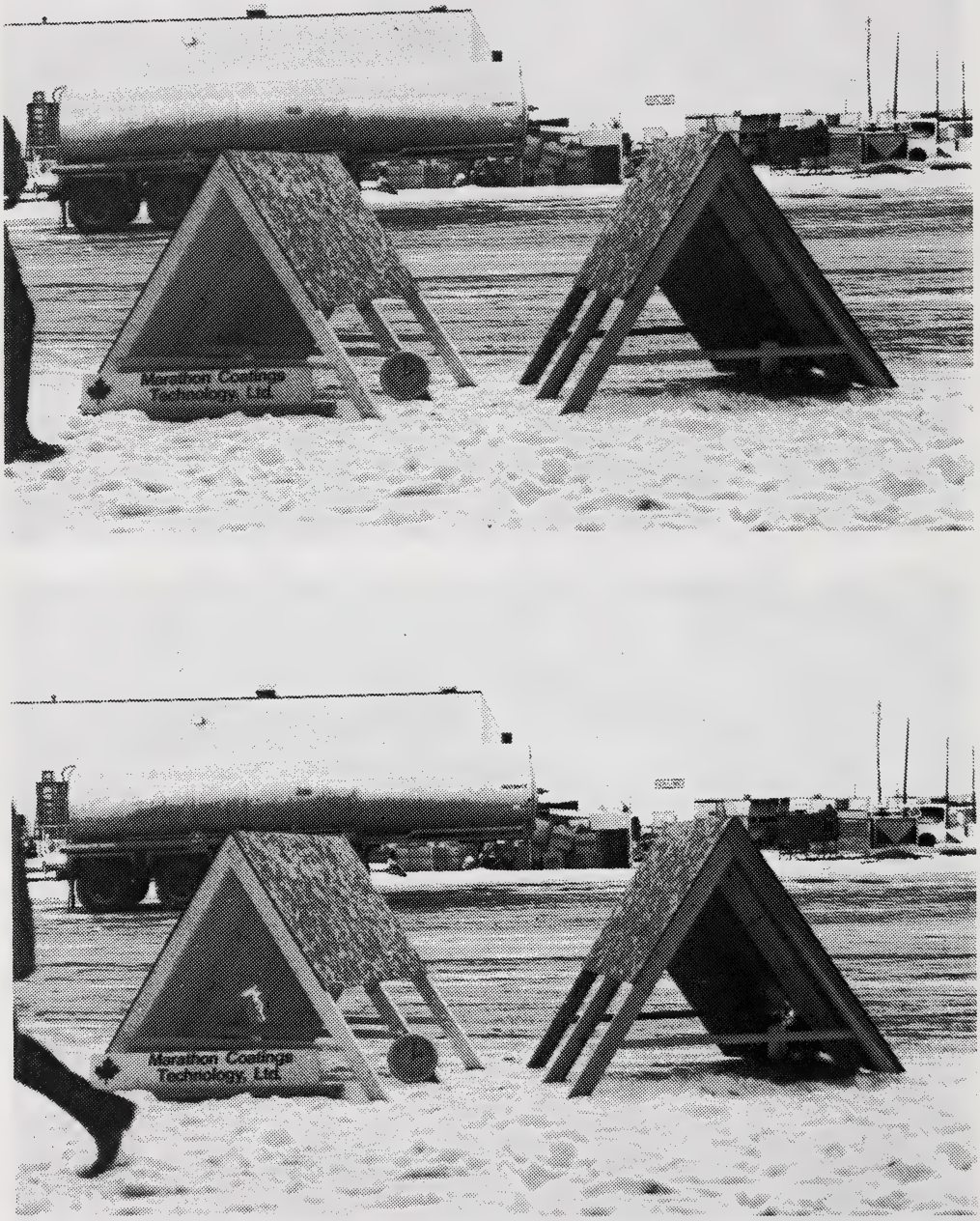

Figure E
Coated and uncoated samples before and at ignition
Elapsed time 0:00

Figure F
Elapsed time 0:50

Figure G
Elapsed time 0:55

Figure H
Elapsed time 1:40

Figure I
Elapsed time 2:10

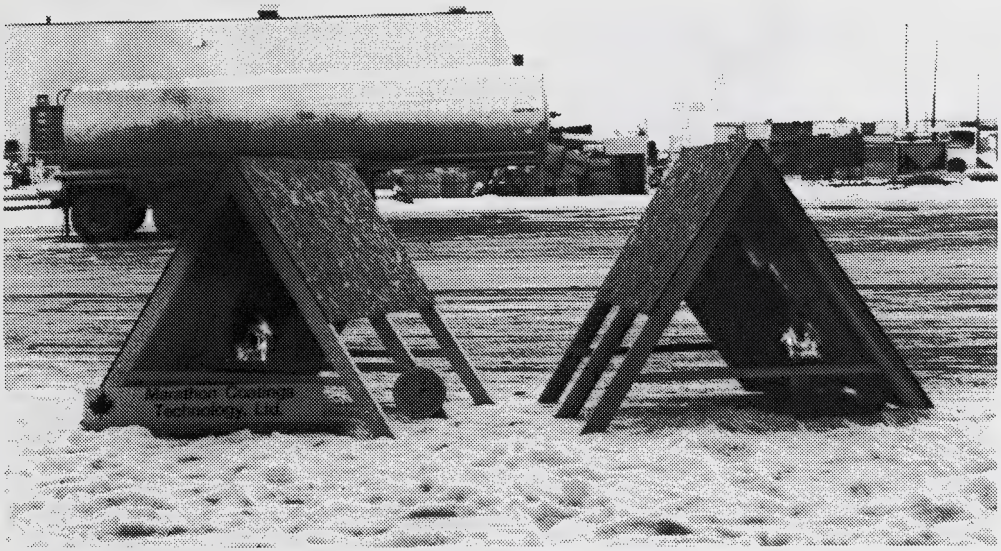

Figure J
Elapsed time 3:47

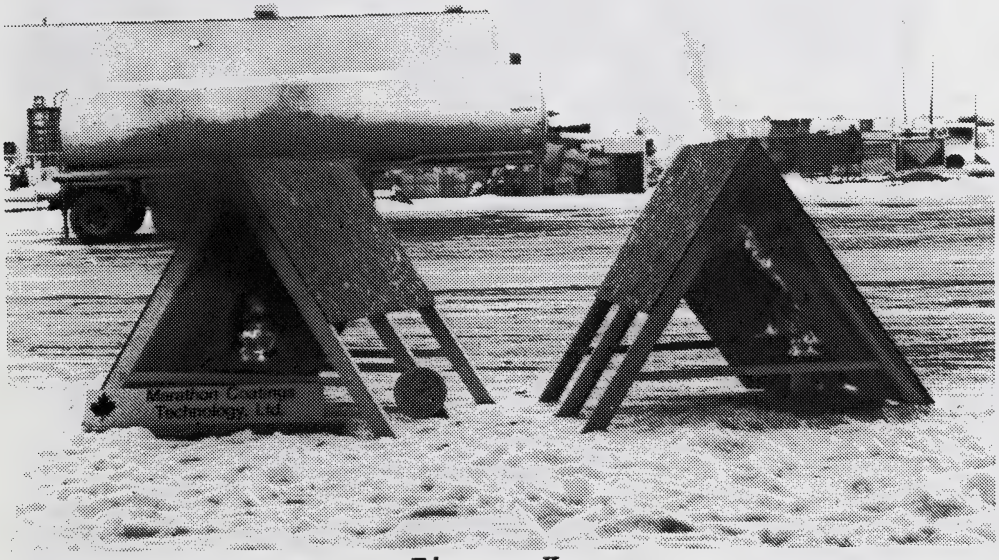

Figure K
Elapsed time 5:05

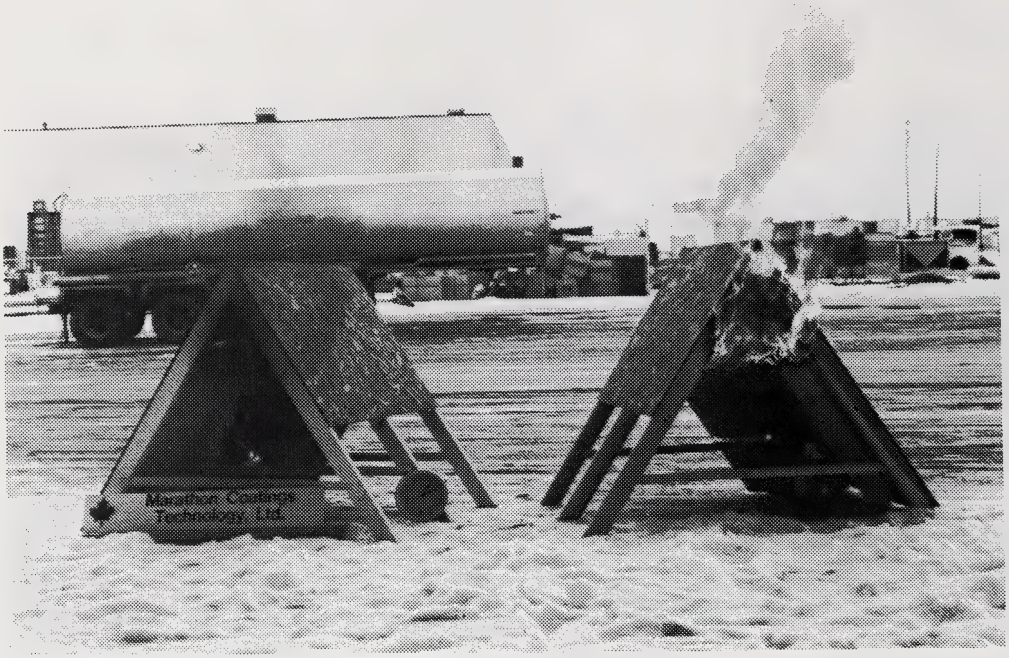

Figure L
Elapsed time 7:00

Figure M
Elapsed time 7:20

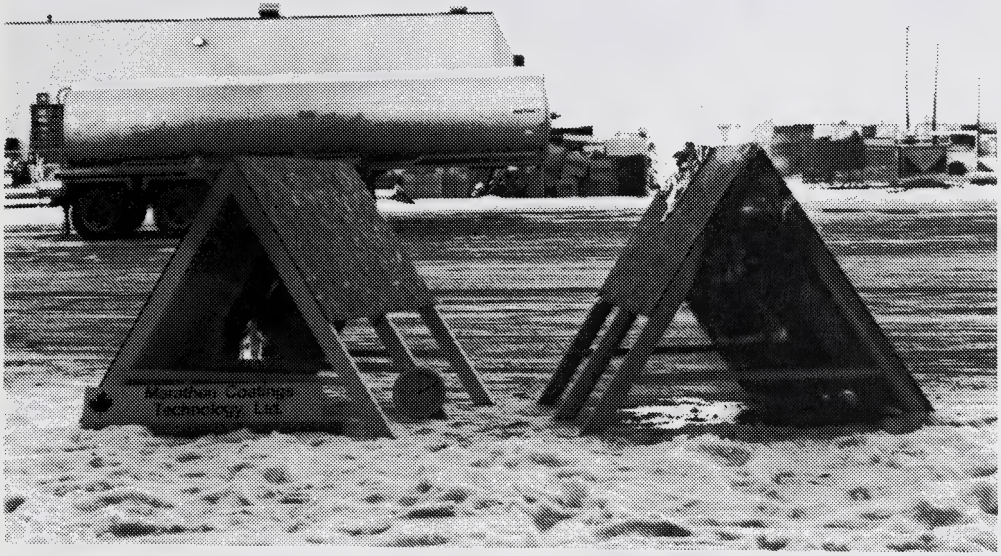

Figure N
Elapsed time 10:30

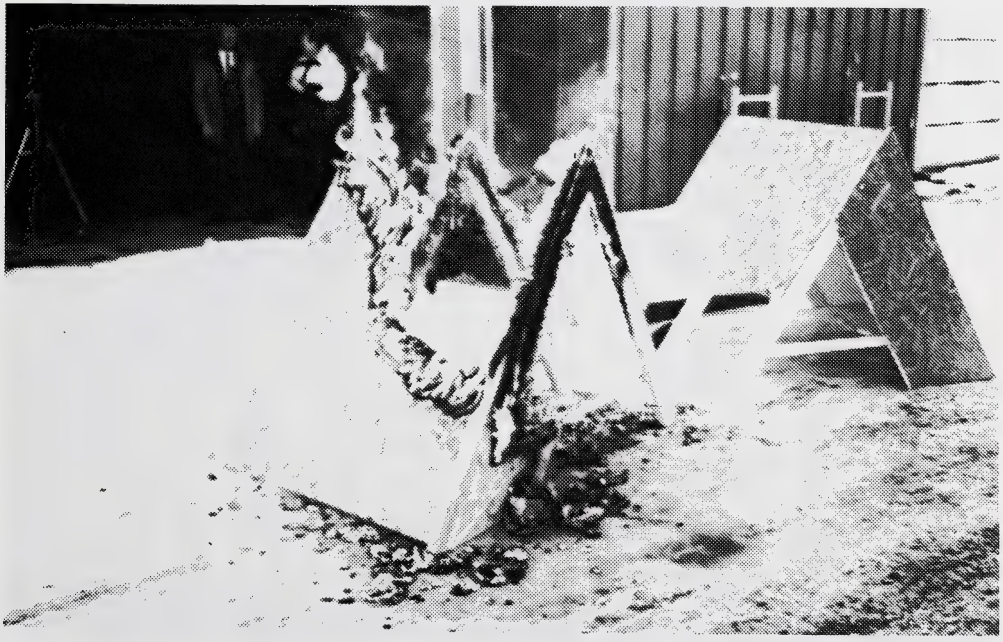

Figure O
Elapsed Time 18:25

Figure P
Elapsed Time 22:00
Charred intumescent coating scraped away to reveal virtually undamaged substrate.

Figure Q
View of exposed lumber ratings stamp.

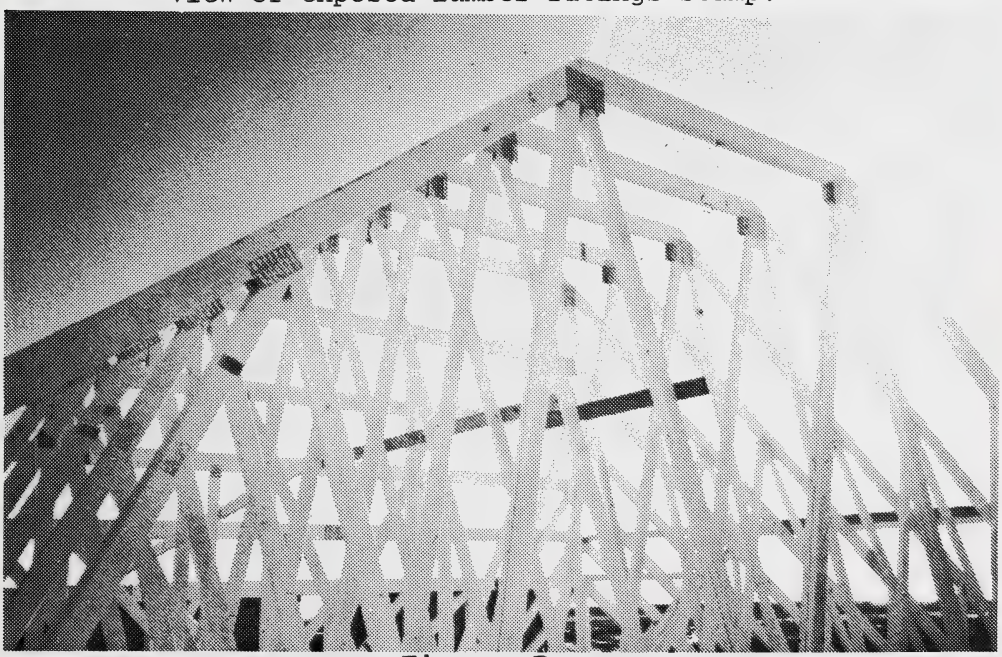

Figure R
View of premanufactured trusses and galvanized metal fasteners.

APPENDIX A

Test Results for
SAFECOAT Formula 451®
applied to various products.

Appendix A[11]

Comparative Test Results for
SAFECOAT Formula 451® applied to various products.

Product	Substrate/ Coverage	Agency	Test Method	Results
SAFECOAT Formula 451	Douglas Fir Deck 200 Sq.Ft./Gal.	Warnock Hersey Labs Vancouver, BC	CAN4 S-102 (10 min.)	Class A F/S - 10 S/D - 75
SAFECOAT Formula 451	Douglas Fir Deck 200 Sq.Ft./Gal.	Warnock Hersey Labs Vancouver, BC	ASTM E84 (10 min.)	Class A F/S - 13 S/D - 82
SAFECOAT Formula 451	SPF Plywood 200 Sq.Ft./Gal.	Warnock Hersey Labs Vancouver, BC	CAN4 S-102 (10 min.)	Class A F/S - 20 S/D - 124
SAFECOAT Formula 451	OSB Sheathing 180 Sq.Ft./Gal.	Warnock Hersey Labs Vancouver, BC	CAN4 S-102 (10 min.)	Class A F/S - 24 S/D - 137
SAFECOAT High Solids	Doug Fir Plywood 90 Sq.Ft./Gal.	Weyerhaeuser Fire Technology Centre Longview, WA	ASTM E84 (30 min.)	Class A F/S - 5 S/D - 25
SAFECOAT Formula 451	Doug Fir Plywood 90 Sq.Ft./Gal.	Weyerhaeuser Fire Technology Centre Longview, WA	ASTM E84 (30 min.)	Class A F/S - 5 S/D - 50
SAFECOAT Formula 451	OSB Sheathing 90 Sq.Ft./Gal.	Weyerhaeuser Fire Technology Centre Longview, WA	ASTM E84 (30 min.)	Class A F/S - 10 S/D - 45
SAFECOAT Formula 451	Presstock (particleboard) 180 Sq.Ft./Gal.	Weyerhaeuser Fire Technology Centre Longview, WA	ASTM E84 (10 min.)	Class A F/S - 2 S/D - 85
SAFECOAT Formula 451	G-P Lebanite 160 Sq.Ft./Gal.	Weyerhaeuser Fire Technology Centre Longview, WA	ASTM E84 (10 min.)	Class A F/S - 10 S/D - 45

11 Source: Marathon Coatings Technology Ltd.